

CHAPTER-3

STUDY AREA

STUDY AREA - 3

Sub-Himalayan West Bengal, consisting of Terai and Duars are spreading through the districts of Jalpaiguri, Alipurduar and plains of Darjeeling are taken as study area for the present dissertation. A belt of moist forests passes along the study areas, at the foot of the majestic Himalayas.

The undulating *Terai* and *Duars* landforms and temporary or permanent virgin elaborate wetland systems are forming a mosaic of tall grasslands, savannas, evergreen and deciduous forests. The slope of the study area is gentle from north to south and located at 25° 57' to 26° 36' N latitude and 89° 54' to 88° 47' E longitude (Terai) & 26°.16' to 27°.0' N latitude and 88°.4' to 89°.53' E longitude (Duars) with altitudinal range varying from 80 to 100 m above mean sea level. The entire region is made up of sand, gravel and pebbles laid down by major and minor rivers and/or stream (*Khola* or *Jhora*) systems like *Teesta*, *Torsa*, *Jarda*, *Raidak*, *Jaldhaka*, *Sankosh*, and several other small rivulets coming from the Darjeeling and Sikkim Himalayas and also from the neighboring countries Nepal and Bhutan. The river Teesta has divided this entire area into two parts and the western part is referred as *Terai* whereas the eastern part is named as *Duars* or *Dooars*. Based on forest types and nature of soil formation the *Duars* region can be further subdivided into the small parts, like Siliguri area as *Western Duars*, the middle or Jalpaiguri part as *Central Duars* and the easternmost end part of Alipurduar is referred as *Eastern Duars*.

The word '*Terai*' meaning dampness and the word '*Duar*' has been derived from the word 'doors', Duars or Dooars acts as a gateway to mountain kingdom of Bhutan and the North-Eastern states of India. The *Terai-Duars* area (Fig. 2) is a land with dense tropical evergreen forests interspersed with numerous marshy areas. It represents a transitional belt between lower hills of the Himalayas and plains and the rolling flat plain of North Bengal.

3.1. TERAJ

The western bank of river Teesta is generally known as *Terai* with very rich and diversified evergreen-forested system. It is a belt of marshy grassland, savannas and forests at the foot of the Himalayan range stretching southwards to about 38 km. Above the *Terai* belt, a forested belt of rock, gravel, and eroded soil covered Himalayan

areas are referred as *Bhabhar*. The *Terai* zone is composed of alternate layers of clay and sand, with a high water table that created many springs and wetlands.

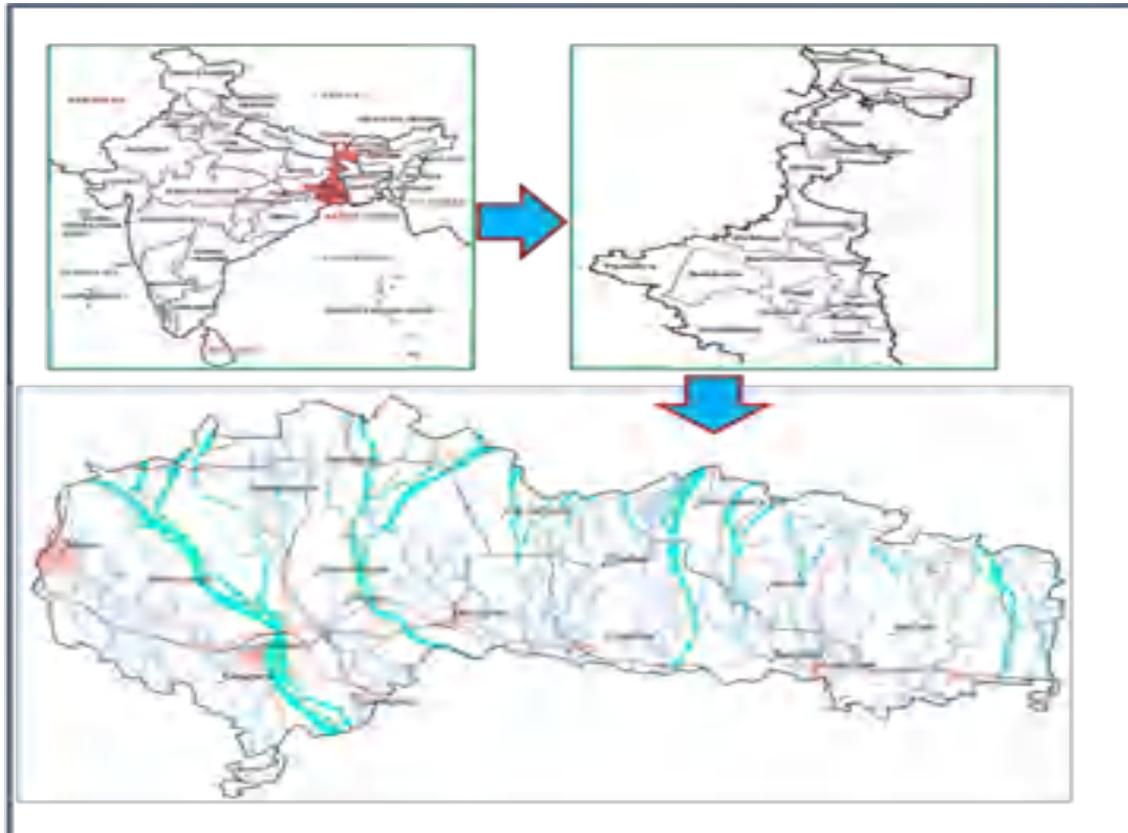


Fig. 2: Map showing the areas of Terai and Duars (www.jalpaiguri.gov.in)

3.2. DUARS

Duars, a land of unending beauty, lies in the sub-Himalayan foothills in Jalpaiguri and Alipurduar districts. The area is starting from the eastern bank of river *Teesta* in the Jalpaiguri district and stretching up to the western bank of the river *Sankosh* in Alipurduar district and is spreading over a span of 130 km of which 40 km area is running along the Himalayan foothills.

Duars with a vast texture of dense forests teeming with wildlife, unending tea gardens, babbling rivers, interspersed with small ethnic settlements, constitute a fascinating tourist destination in this part of the country. *Duars* offers some magical landscape with fascinating view of river valleys and hills and this beautiful landscape is still unknown to the large section of tourists.

The Duars area is specially noted for its Protected Areas in IUCN guideline and includes Gorumara National Park, Buxa Tiger Reserve, Buxa National Park, Jaldapara

National Park, Chapramari wildlife Sanctuary etc. These in-situ conservatories are harbouring a rich and fascinating diversity of flora, fauna and microbes including several endemic rare and threatened species. The vast texture of massive trees sheltering varieties of orchids, other epiphytes and climbers and the forests resounded with songs of birds and call of wild animals make it a veritable paradise for nature lovers and eco-tourism.

3.3. LOCATION

Terai [25° 57' to 26° 36' N latitude and 89° 54' to 88° 47' E longitude] and Duars [26°.16' to 27°.0' N latitude and 88°.4' to 89°.53' E longitude]

3.4. DRAINAGE SYSTEM

The foothills of Terai and Duars are intersecting by a good number of perennial rivers/streams coming down from the Himalayan glaciers. The major such rivers are *Mahananda, Balason, Mechi, Karotoa, Sahu, Panga* etc along with several small streams are continuously proving the life support to greenery of Terai regions. Duars regions are also blessed with several big and small rivers like *Teesta, Torsa, Karala, Jaldhaka* and *Diana* and their rivulets makes the area paradise of biodiversity. All these rivers originated from Himalayan hills, flow from North-east to South-West and are rain fed, except *Teesta* which has its origin from the Jemu glaciers in North Sikkim. Though they are tame, shallow and nearly dry during summer, but generally overflow during monsoon sometime causing heavy floods. The numerous low laying areas holds good volume of rain water and saves terrestrial areas from inundation.

3.5. SOIL

Soil of the study area is basically porous in nature, deep, light textured, highly acidic, with moderate organic matter, low Phosphate, Potassium, and micronutrient contents (Monda et al., 2018); (Anonymous 1993). Soil consists of soft sands of different sizes and is interspersed with humus along with variable sized gravels and boulders. The soils are brought down by rivers coming down from hills and their tributaries those are bringing materials from a height of about 3048 m of Himalayan ranges and are deposited layer by layer in the form of soil all over the study area. The greater part of the region is covered with alluvial soils, ranging from pure sand to clay, but mainly sandy loam in nature. In the upland of the north of the *Duars*, the soil is ferruginous clay and is particularly well-suited to the growth of the tea plants (Sarkar, 2011). The

Western Duars has numerous old and/or dead river beds which have been left over by the streams. Near the hills soils are composed of more stones and boulders while lower down they contain gravel and in the plain they contain more sand with humus.

3.6. CLIMATE

The weather conditions of the study area are more or less remains pleasant throughout the year. Three predominant seasons namely pre-monsoon, monsoon and post-monsoon are quite prominently recognizable in these areas. The pre-monsoon starts from the 1st week of February and extended up to the middle of May, whereas, monsoon starts from the last week of May and extended up to end of September. The post-monsoon season begins from the 3rd week of November and extended up to last week of January. Climatic data for the study area is collected from Central Tobacco Research Institute at Dinhat and Hydromet division, India Meteorological Department, Kolkata.

3.7. FOREST COVER AND VEGETATION TYPES

Total recorded 16831.87 sq. km area belongs to forest land in the West Bengal and it constitutes 18.96 % of the geographical area. This total forested land constitutes 3036.51 sq. km. is Very Dense Forest, 4208.37 sq. km. is Moderate dense forest and rest 9586.99 sq. km. is under Open forest (Anonym., 2021). The forest cover including the forests created outside the recorded forest area is 15.68% of the geographical area. Estuarine water bodies like rivers and creeks in mangrove forest of Sundarban areas and river flowing through the recorded forest land in Jalpaiguri and other districts have been included while computing the forest cover. Similarly large portions of farm forestry plantations, raised outside forest land, having forest like micro-ecosystem, have been enumerated as forest cover. As per classification of satellite imageries, the vegetation cover of the state is more than 27% of the geographical area as in 2006. Part of the world's largest mangrove forest, Sundarbans biosphere reserve and Sundarban Ramsar site located in southern West Bengal. There are six national parks (Neora Valley NP, Jaldapara NP, Buxa NP, Singalila NP, Gorumara NP, Sundarban NP) and 16 Wildlife Sanctuaries (Ballabhpur WLS, Bethuadahari WLS, Bibhutibhushan WLS, Chapramari WLS, Haliday Island WLS, Jorepokhri WLS, Lothian Island WLS, Mahananda WLS, Narendrapur WLS, Raiganj WLS, Ramnabagan WLS, Sajnakhali WLS) and several localized protected areas (Mayurjharna Elephant Reserve, Tilason Forest etc) in West Bengal. According to Champion and Seth (1968), the total forest type of West Bengal can be categorized into following major groups:

3.7.1. Northern tropical wet evergreen forests (1B)

This type of forest patches are located at plain regions of North Bengal with an area of around 167 sq km and spreading over the areas like Bagdogra range of Kurseong division, Khutimari areas of Jalpaiguri division, Damanpur, Cheko, Gadadhar, Rajabhatkhawa, Raidak of Buxa Tiger Reserve at an elevation of 150 metre. The most dominating and common plants of such forest are *Callicarpa arborea* Roxb., *Casearia vareca* Roxb., *Chukrasia tabularis* A. Juss., *Daemonorops jenkinsiana* (Griff.) Mart., *Dalbergia sissoo* DC., *Magnolia champaca* (L.) Baill. ex Pierre, *Shorea robusta* Gaertn., *Tectona grandis* L. f. etc.

3.7.2. Northern sub-tropical semi-evergreen forests (2B)

This type of forest patches are spreading over an area of 25 sq km of North Bengal. The most dominating species of this areas are *Calamus erectus* Roxb., *Chukrasia tabularis* A. Juss., *Commiphora wightii* (Arn.) Bhandari, *Lagerstroemia reginae* Roxb., *Magnolia champaca* (L.) Baill. ex Pierre, *Shorea robusta* Gaertn., *Alstonia scholaris* (L.) R. Br., *Terminalia arjuna* (Roxb. ex DC.) Wright & Arnt. etc.

3.7.3. Tropical Moist Deciduous Forests (3C)

This type of forest patches are mainly located at sub-Himalayan or foothills of Himalaya mostly covering Terai and Duars of North Bengal and also called as sub-Himalayan secondary wet mixed forest and spread over an area of 1757 sq km. The dominating species of the region are *Aporosa octandra* (Buch.-Ham. ex D. Don) Vickery, *Shorea robusta* Gaertn., *Magnolia champaca* (L.) Baill. ex Pierre, *Lagerstroemia parviflora* Roxb., *Terminalia bellirica* (Gaertn.) Roxb., *Acacia nilotica* (L.) Delile, *Tectona grandis* L. f., *Callicarpa arborea* Roxb., *Casearia vareca* Roxb., *Chukrasia tabularis* A. Juss., *Coffea benghalensis* B. Heyne ex Schult. *Carallia brachiata* (Lour.) Merr., *Dalbergia sissoo* DC., *Maesa indica* (Roxb.) A. DC. are found in forest margin mostly at wet localities. The well represented grass species in this region are *Setaria palmifolia* (J. Koenig) Stapf, *Centotheca lappacea* (L.) Desv., *Eragrostis uniolooides* (Retz.) Nees ex Steud., *Pogonatherum paniceum* (Lam.) Hack., *Oplismenus composites* (L.) P. Beauv., *Oplismenus burmanni* (Retz.) P. Beauv. etc.

3.8. MEDICINAL PLANTS CONSERVATION AREAS (MPCAs)

MPCA are the dense forest patches with diversity plant population lies within the in-situ conservatories. The area (MPCA) also has a great significance in the forested areas

of the Sub-Himalayan landscape along the forest and riverine ecosystem.

3.8.1. North Sevoke MPCA (Mahananda Wildlife Sanctuary)

The name of the site 'North Sevoke' covers the forest area consisting of compartment 1 (a) & (b) respectively. The area has been declared as "Mahananda Wildlife Sanctuary" vide Govt. of West Bengal's notification no. 5384-For dated June the 24th, 1976. The sanctuary was under the administrative control of Kurseong Forest Division till 1988. This has been brought under the control of Divisional Forest Officer, Wild Life – I, Vide Principal Chief Conservator of Forests, West Bengal's O.O. No. 8-M/8-88, dated 11/08/1988. The total physical area of block North Sevoke measures over 379.59 ha. as per the 'Mahananda Management plan' of Mahananda Wild Life sanctuary (Fig. 5). And the selected site of MPCA at North Sevoke is 379.59 ha. out of which an area of 100 ha. only is selected at compt 1(a) for the study of MPCA at North Sevoke (Table 3.) The details are shown as follows:

Table 3: Area (Ha) in North Sevoke MPCA

BLOCK – COMPT.	AREA (HA.)
NORTH SEVOKE – 1 (A)	321.32
NORTH SEVOKE – 1 (B)	58.27
TOTAL	379.59

This MPCA demarcated at North Sevoke block of compartment 1 (a) is under the administrative control of 'Wildlife Division – I, Darjeeling' under sub-division of Kurseong. It is under the Forest Range named as '10th, mile under 'Sevoke Beat'.

3.8.1.1. Physical description of the Site

The selected site of North Sevoke MPCA lies within the latitudes of 26°37'27"N & longitudes of 88°12'88.34"E. It is located at the southern part of Darjeeling district on the west bank of river Tista. According to the classification (Rodger & Panwar) of Biogeographic region of India now in use, the selected site falls in zone 7 (Gangetic plains), province 3 (Lower Gangetic plains), sub-division Bengal Duars. The total area of Mahananda Wild Life Sanctuary is 12,903.97 ha.

3.8.1.2. Location

Map of West Bengal showing location of MPCA at North Sevoke Compartment 1 (a) indicating red coloured square shaped mark in Darjeeling District bordering to Jalpaiguri District. (Fig.1)

Another Map of Wild Life – I Division showing location of MPCA at North Sevoke Comptt. 1 (a) under Sevoke Beat of North Range 10th Mile indicating Red star shaped mark on it. (Fig.2). GPS Map of North Sevoke MPCA showing boundary demarcation & way points (Fig.3)

3.8.1.3. Climate

The climate of this MPCA site varies from tropical to sub-tropical with rise of elevation. The highest temp. of about 36°C occur in the lower reaches in the month of May and June. December & January are the coldest month with night temp falling down to 2°C on the hills. Ground frost is not very common in this area.

3.8.1.4. Temperature

North Sevok MPCA lies in the moist tropical climatic zone. The average temperature during day time varies from 10°C to 13°C (October to February), 27°C to 32°C (May to September) and, 24°C to 27°C during March to April (Table 4). The highest recorded temperature was 39°C and the lowest was 2°C (Fig. 3.) (Ref. 5th Working Plan of Buxa Division).

3.8.1.5. Rainfall

The annual rainfall is in the region of 3500 mm. Monthly average being highest in July (900 mm) and lowest in December (40 mm). The humidity level is fairly high (Table 5, Fig.4).

3.8.1.6. Drainage

Tista, a perennial snow fed river, originates from the Kanchanjunga snows and flows down along the eastern boundary of the MPCA. It is the only snow-fed river in the region. Mahanadi and Gulma khola, the two springs fed water courses play major role in the ecology of this forest. The other significant water course in the MPCA is Nandi khola.

Table 4: Annual temperature of North Sevoke MPCA (2009–2020)

Year	Mean min. Ave. temp. (°C)	Mean max. Ave. temp. (°C)
2009	5	11
2010	7	13
2011	8	16
2012	10	18
2013	11	20
2014	13	22
2015	14	19
2016	14	20
2017	15	20
2018	12	19
2019	11	20
2020	4	18
Ave. Annual Tem.	14.9	9.33

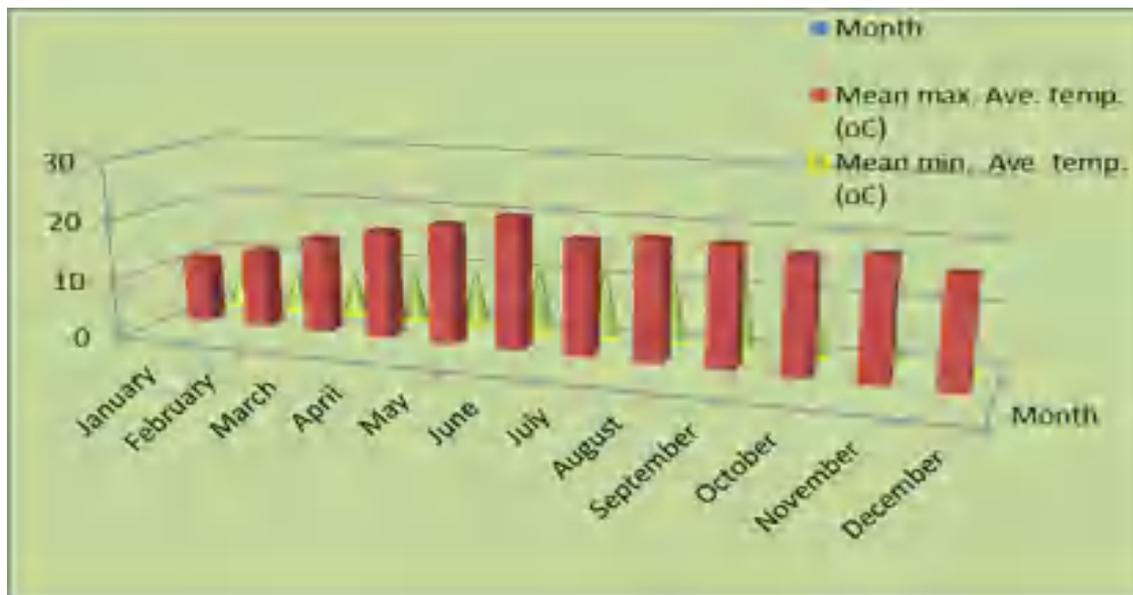


Fig. 3: Annual temperature of North Sevoke MPCA (2009–2020)

Table 5: Annual Rainfall of North Sevoke MPCA (2009–2020)

Year	Average Rainfall (mm)
2009	21.7
2010	23.1
2011	46.7

2012	115.8
2013	187.2
2014	570
2015	791.7
2016	634.3
2017	438.3
2018	124.5
2019	23.5
2020	9
Ave. Annual Rainfall	248.48

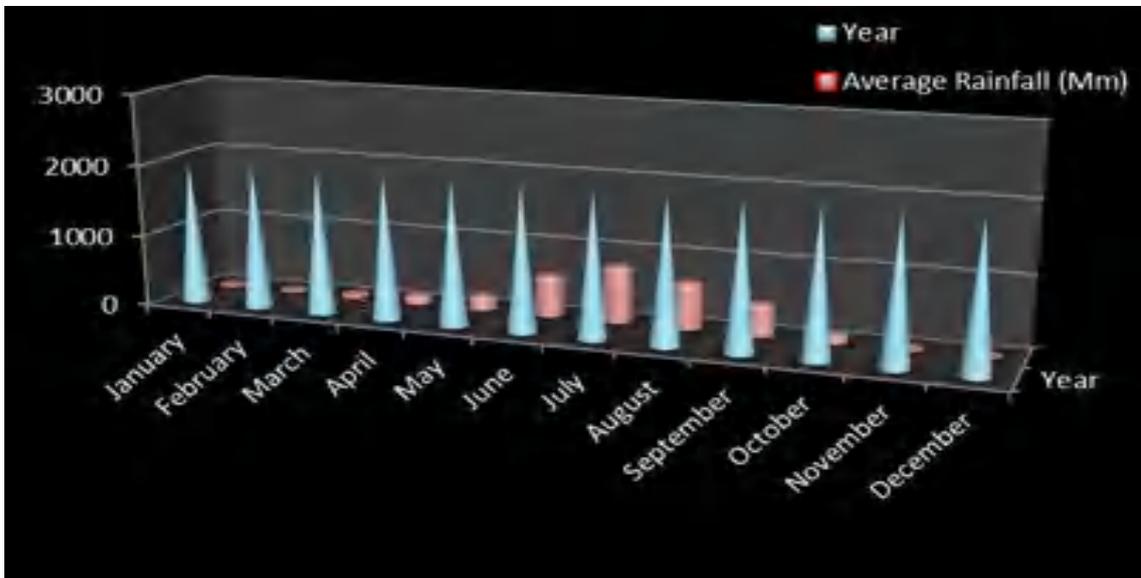


Fig. 4: Rainfall (mm) of North Sevoke MPCA (2009–2020)



Fig. 5: Entry gate of North Sevoke MPCA

3.8.2. North Rajabhatkhawa (NRVK) MPCA (Buxa National Park)

The name of the selected site of MPCA is North Rajabhatkhawa (Fig. 8), constituting of compartment 8 & 9 over the area of 564.15 ha. respectively. But our study area of MPCA is within 400 ha. only. The legal status of this forest goes back to the year 1866 when the forest department undertook the forests of Buxa Tiger Reserve and prior to that these used to be an unoccupied wasteland, subject to indiscriminate felling. Those forests came under British rule in 1865 and the first reservations were made in 1879 according to the IFA (Act VIII of 1878) and the process continued till 1940. Thus most of the forest areas of the Tiger Reserve enjoy the status of Reserved Forests. The forest area of NRVK 8 and 9 comes under the legal status of Reserve Forest which is a part of the buffer zone of the Buxa Tiger Reserve.

This MPCA is under the jurisdiction of BTR (E) Division under sub-division of Alipurduar. It is under the Buxa road beat of Buxaduar Range. It falls under the administrative control of Deputy Field Director, Buxa Tiger Reserve (East), head quarter at Alipurduar Sub-division.

3.8.2.1. Physical description of the site

The MPCA lies between latitudes 26°41'N and longitude 89°33'E. It is altitudes recorded as 158 m from Mean Sea Level. It is the area lying outside sanctuary treated as buffer zone. Gradient is gentle. Land configuration is even & the aspect is flat.

3.8.2.2. Location Map of MPCA

The MAP of Buxa Tiger East Division showing the location of MPCA at NRVK 8 & 9 Compt. under Buxa Road Beat of Buxaduar Range indicating pink coloured star shaped mark. (Fig. 2)

3.8.2.3. Climate

The climate of this MPCA site varies from tropical to sub-tropical with rise of elevation. The highest temperature of about 36°C occur in the lower reaches in the month of May and June. December & January are the coldest month with night temp falling down to 2°C on the hills. Ground frost is not very common in this area.

3.8.2.4. Temperature

The North Rajabhatkhawa MPCA is lies in the moist tropical climatic zone. The average temperature during day time varies from 12°C to 21°C (October to February),

27°C to 32°C (May to September) and, 24°C to 27°C during March to April (Table 6). The highest recorded temperature was 39°C and the lowest was 2°C (Fig. 6.) (Ref. 5th Working Plan of Buxa Division).

3.8.2.5. Rainfall

South-West Monsoon is the main source of rain fall. The location of MPCA receives maximum rainfall from mid June to September. The rain fall is very high during the month of June, July and August. It subsides from the early September and completes by the 1st week of October. December is the driest month with minimum rainfall. March receives maximum of winter rain. Pre monsoon showers accompanied by hail and thunder storm occur in the month of April to May. The maximum rainfall recorded was 577 cm and minimum was 543 cm. The average annual rainfall was recorded 560 cm (Fig. 7 & Table 7).

3.8.2.6. Drainage

The forest tracts of this MPCA is intercepted by numerous rivers, streams and jhoras of varying sizes which usually originated in the hills on the North and flow southwards. They rise and fall with great rapidity and frequently change their course causing damage to the forest. The Principle Rivers that flow nearby this MPCA are Dima, Jainty, Bala river and includes Buxa Jhora, Guenala & Hatinala respectively.

Table 6: Annual temperature in NRVK MPCA (Source: meteorological Department, Jalpaiguri, India)

Year	Mean Min. Ave. Temp. (°C)	Mean Max. Ave. Temp. (°C)
2009	3	20
2010	3	23
2011	9	23
2012	16	26
2013	14	27
2014	11	29
2015	16	28
2016	17	31
2017	16	28

2018	11	29
2019	6	25
2020	5	22
Annual Average	10.58	25.91

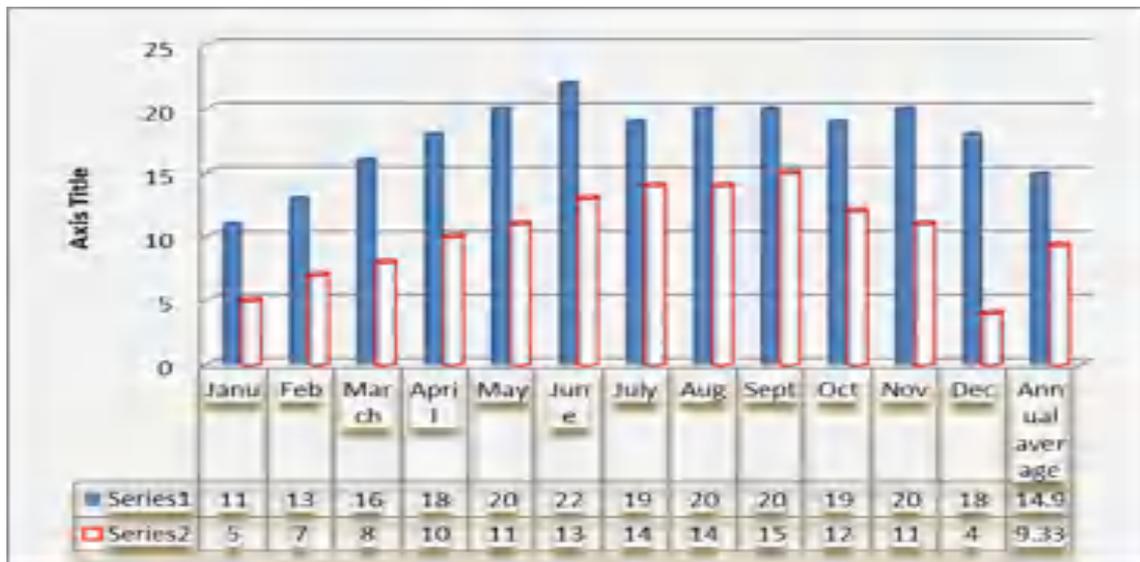


Fig. 6: Annual temperature of NRVK MPCA (2009–2020)

Table 7: Annual rainfall in NRVK MPCA during 2009 – 2020 (Source: Meteorological department, Jalpaiguri, India).

Year	Average Rainfall (mm)
2009	18.7
2010	25.1
2011	46.7
2012	113.8
2013	190.2
2014	560
2015	782.7
2016	641.3
2017	439.3
2018	121.5
2019	23.5
2020	9
Annual rainfall	248.48

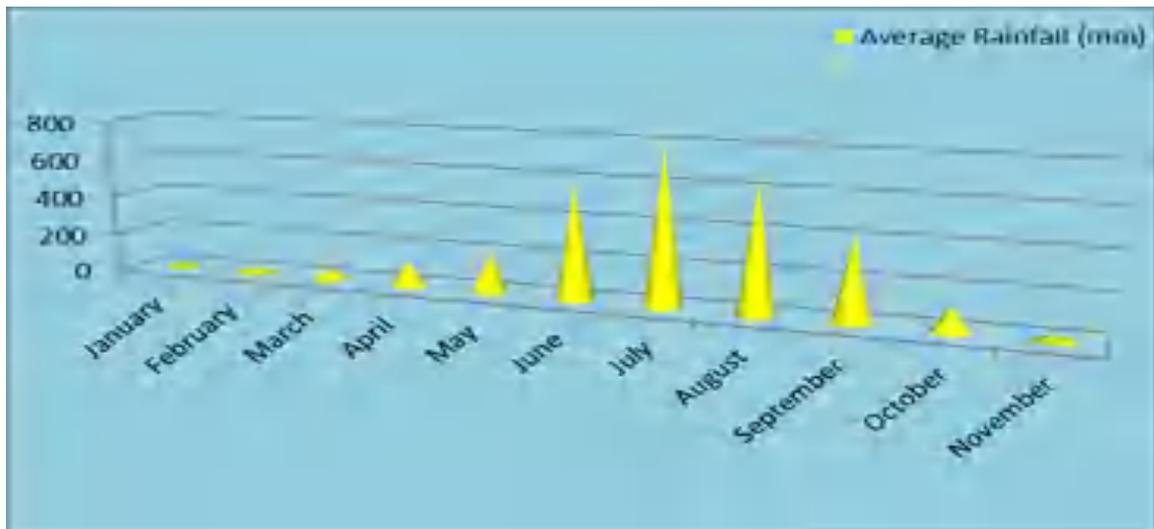


Fig. 7: Annual rainfall in NRVK MPCA (2009–2020)

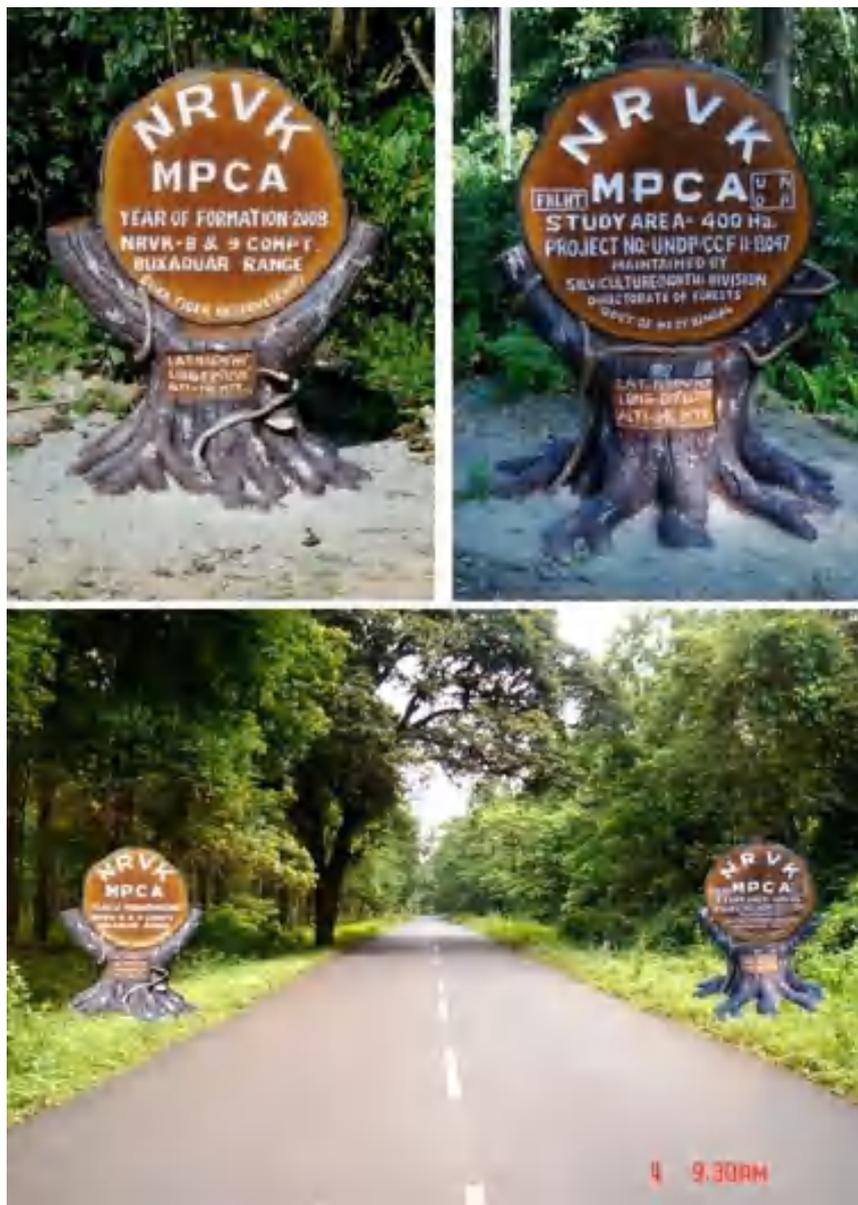


Fig. 8: Entry gate of North Rajabhatkhawa MPCA

3.8.3. Sursuti MPCA (Gorumara National Park)

The selected site of this MPCA is situated at Sursuti Block (Fig. 12.) under Compartment no. 4 consists of 343.18 ha. forest area. Out of that our study area of MPCA is 100 ha. only. The north boundary of this MPCA is an artificial forest boundary, east is PWD road, south is an artificial boundary and the west is Neora river and an artificial forest boundary. This MPCA is under the forest jurisdiction of Jalpaiguri Forest Division. The MPCA site falls under Lataguri Forest Range under Barodighi beat. It comes under the administrative control of Divisional Forest Officer, Jalpaiguri Forest Division, headquarter at Jalpaiguri. The legal status of this MPCA is a Reserve Forest. The legal position of this Jalpaiguri Division goes back to the period of British Rule. The district of Jalpaiguri came into an administrative unit on 1st January 1869, by the amalgamation of the western duars district with Jalpaiguri Sub-division of Rangpur. The so called western duars was formed in 1964 from land taken from Bhutan. The forest dealt within this Division, before they came under the British Rule in 1865, continued to be open to indiscriminate felling and were described as “Open Forests”. The first reservations were made in 1879 according to the Indian Forest Act (Act VIII of 1878). Right were enquired into by the Forest Settlement Officer during the year 1890 to 1896 and revised notification was issued in the year 1895 (notification no. 3147 – For, dated 02/07/1895). The forests have been reserved from unoccupied waste.

3.8.3.1. Physical Description of the Site

The proposed MPCA, Sursuti lies between latitude 26°48'N and longitudes 88°49'E. Altitude recorded as 165 mtr. This MPCA area is lying outside the Gorumara National Park but adjacent to this park separated by a PWD road (state highway) runs from Chalsa to Jalpaiguri. Land configuration is even. Gradient is gentle with flat aspect.

3.8.3.2. Location Map of MPCA

MAP of West Bengal showing location of MPCA at Sursuti-4 Compartment in northern part of Bengal within the district Jalpaiguri.

3.8.3.3. Climate

The climate of this Sursuti MPCA site varies from tropical to sub-tropical elevation. The highest temperature of about 36°C occurs in the lower reaches in the month of May and June. December & January are the coldest month with night temp falling down to 2°C on the hills. Ground frost is not very common in this area.

3.8.3.4. Temperature

Sursuti MPCAs are lies in the moist tropical climatic zone. The average temperature during day time varies from 7.5°C to 21°C during winter (November to February), 16°C to 32°C (May to October) and, 24°C to 26.5°C during March to April (Table 4). Nights in winter are fairly cold (Fig. 9, 11 & Table 8). Frost is almost rare phenomena; however it occurs in Baradighi which is very close to MPCA.

3.8.3.5. Rainfall

The southwest monsoon starts from the middle of May and lasts until the end of September. The heaviest rainfall occurs during the month of July & August. The average annual rainfall is about 3390.80 mm (table 9 & Fig. 10).

The following table gives total yearly rainfall report in mm during the last ten years (2009 to 2020) near to MPCA proposed site.

3.8.3. 6. Drainage

The chief water sources are the Chel, Neora and Mal rivers join Teesta West of Lataguri Range which is a part of this selected MPCA forest. The other perennial jhoras are Bamoni Jhora, Sursuti Jhora and Monpala Jhora which exists within the MPCA.

Table 8: Annual temperature in Sursuti MPCA during 2009 – 2020 (Source: Meteorological department, Jalpaiguri, India).

Year	Mean Min. Ave. temp. (°C)	Mean Max. Ave. temp. (°C)
2009	5.2	10
2010	6	9
2011	7	12
2012	11	15
2013	12	19
2014	12	20
2015	13	18
2016	14	19
2017	15.5	21
2018	12	19
2019	7.3	22
2020	-4	10
Ave. Annual Temperature	9.25	16.16

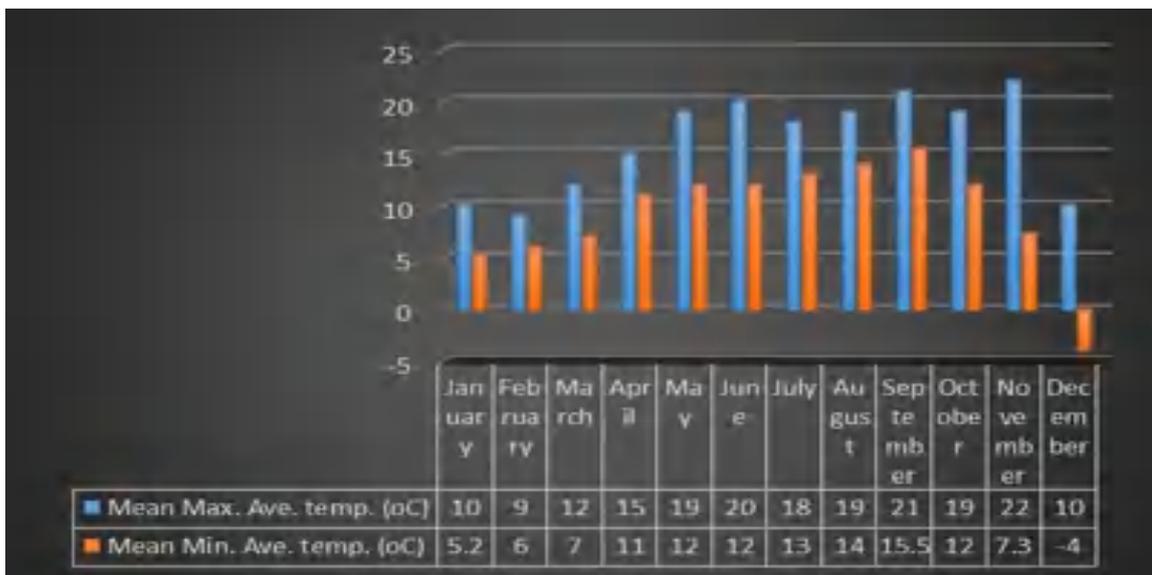


Fig. 9: Annual temperature of Sursuti MPCA (2009–2020)

Table 9: Annual rainfall of Sursuti MPCA during 2009 – 2020 (Source: Metrological department, Jalpaiguri, West Bengal, India)

Year	Average Rainfall (Mm)
2009	18.7
2010	21.1
2011	31.7
2012	111.8
2013	175.2
2014	670
2015	71.7
2016	612.3
2017	425.3
2018	147.5
2019	43.2
2020	7
Annual Rainfall	244.79

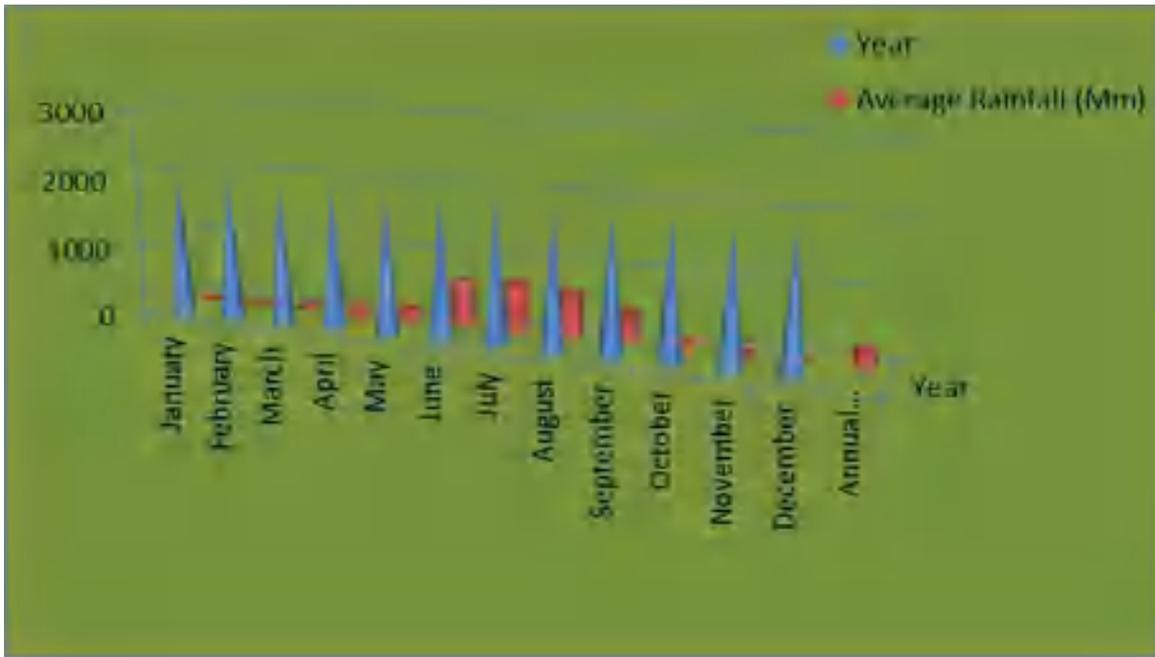


Fig. 10: Annual rainfall of Sursuti MPCA (2009–2020)

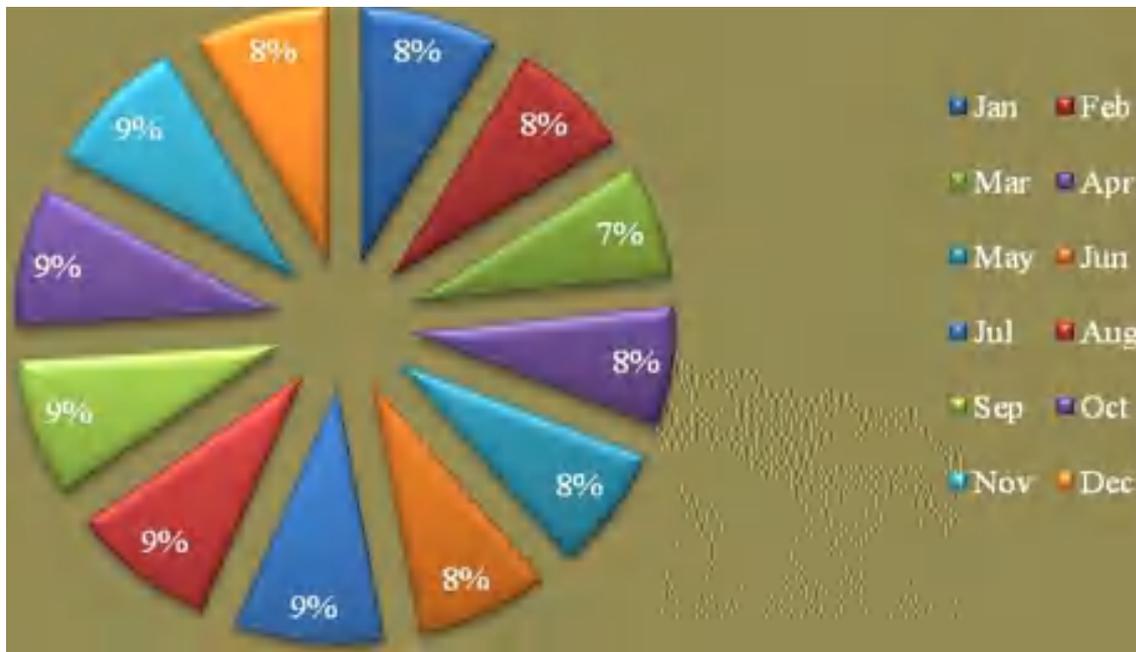


Fig. 11: Humidity of Sursuti MPCA (2009–2020)



Fig. 12: Entry gate of Sursuti MPCA